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3 FLUID FLOW TRANSDUCER MODULE AND ASSEMBLY

4 CROSS-REFERENCE TO RELATED APPLICATION

5 This application claims the benefit of U.S. Provisional  
6 Patent Application Serial No. 60/393,288, filed July 2, 2002 in  
7 the name of David R. Dussault.

8

9 BACKGROUND OF THE INVENTION

10 1. Field of the Invention

11 The invention relates to fluid flow transducers and is  
12 directed more particularly to a fluid flow transducer module which  
13 is adapted for combining with other such modules of similar  
14 structure to provide a fluid flow transducer module including a  
15 stack of modular modules including a selected number of flow  
16 transducers.

17 2. Description of the Prior Art

18 In the fluid chiller and fluid conditioning systems arts, a  
19 common requirement is to measure the fluid flow rate in various  
20 parts of recirculating loops, which may be many in number. The  
21 flow measurement often is done electronically by means of off-the-  
22 shelf flow transducer technologies. The devices produce an  
23 electronic signal, of a type selected from known various types,  
24 which is interpreted by a control system and the fluid flow value  
25 is displayed or retransmitted for monitoring purposes. In some

1 cases, this signal is used internally as feedback in a control  
2 loop for controlling flow in the process channel or device.

3 The aforementioned single-channel flow transducer devices are  
4 available in a wide range of flow ratings, employing several  
5 sensor technologies, and are available from many manufacturers.  
6 Often fluid chillers and/or conditioning systems require  
7 monitoring of multiple flow channels. This has typically been  
8 accomplished by off-the-shelf single-channel flow transducers  
9 assembled, usually in a parallel flow pattern, with a variety of  
10 plumbing fittings, tubes and hoses in some sort of manifold  
11 arrangement.

12 Although the arrangement of such standard devices has been  
13 functionally correct, building the manifolds has been very labor-  
14 intensive, particularly as the number of flow channels increases.  
15 In some cases, custom-machined parts and fittings are required to  
16 achieve the desired connection type and size the conditioning  
17 system requires, which, in itself, is usually expensive. The  
18 large number of parts and fittings, and associated manufacturing  
19 and installation labor, may be reduced by consolidating such parts  
20 and fittings and by integrating their functionality into a multi-  
21 channel flow transducer unit. However, the fully integrated unit  
22 itself tends to be expensive and, once developed, is difficult to  
23 adapt to other applications.

24 Each multi-channel configuration typically requires a custom  
25 design and custom tooling, including special molds, for each

1 unique application. If a 4-channel "module" is required for one  
2 particular project, a custom 4-channel mold must be utilized. If  
3 there is a future requirement for a 6, 8 or 10 channel flow  
4 transducer, each subsequent variation requires further development  
5 and custom tooling costs, which for relatively low-volume  
6 applications can be cost prohibitive.

7 There is an increasing demand in the market for fluid  
8 chillers and/or conditioning systems, for overall cost reduction  
9 and, concurrently, for varied and numerous combinations of needs  
10 for fluid flow measurement.

11

#### 12 SUMMARY OF THE INVENTION

13 An object of the invention is, therefore, to provide a low-  
14 cost flow transducer module which can be combined with other  
15 similar modules to provide custom flow transducer assemblies which  
16 reduce the physical space required for the transducers and  
17 associated piping, improve manufacturability, reduce assembly  
18 labor, and improve overall reliability, functionality and  
19 serviceability of the system.

20 With the above and other objects in view, a feature of the  
21 present invention is the provision of a fluid flow transducer  
22 module comprising a fluid flow conduit having an inlet for  
23 receiving fluid from a fluid discharging apparatus, a transducer  
24 associated with the conduit for measuring rate of flow of the  
25 fluid through the conduit, and an interface in communication with

1 the transducer and adapted to receive rate of flow measurements  
2 from the transducer and to effect at least one of (i) a display of  
3 measurements to an operator, (ii) a remote monitoring of  
4 measurements, and (iii) a corrective signal for modifying the  
5 rate of flow. The fluid flow conduit is provided with an outlet  
6 for flowing the fluid from downstream of the transducer to a  
7 reservoir for the fluid, the outlet extending transversely of the  
8 conduit. The invention further comprises a housing for the  
9 conduit, conduit inlet, conduit outlet, and transducer, the  
10 housing having opposed first and second walls, each of the walls  
11 having an opening for the outlet therein. At least one of the  
12 walls is adapted for stacking engagement with a second fluid flow  
13 transducer module of a substantially same structure, such that the  
14 outlets of the module are aligned to form portions of a common  
15 conduit.

16 In accordance with a further feature of the invention, there  
17 is provided a fluid flow transducer module comprising first and  
18 second fluid flow transducer modules. Each of the modules  
19 comprises a fluid flow conduit having an inlet for receiving fluid  
20 from a fluid discharging apparatus, a transducer associated with  
21 the conduit for measuring rate of flow of the fluid through the  
22 conduit, and an interface in communication with the transducer and  
23 adapted to receive and act on rate of flow measurements from the  
24 transducer. The fluid flow conduit is provided with an outlet for  
25 flowing the fluid from the transducer to a reservoir, the outlet

1 extending transversely of the fluid flow conduit. A housing is  
2 provided having opposed first and second walls, each of the walls  
3 having an opening for the outlet therein, at least one of the  
4 walls of the first module being adapted for stacking engagement  
5 with at least one of the walls of the second module. The first  
6 and second modules are joined together at the one walls to form  
7 the fluid flow transducer assembly, and the fluid flow conduit  
8 outlets are thereby aligned to form a common conduit in  
9 communication with a reservoir for the fluid.

10 In accordance with a still further feature of the invention,  
11 there is provided a fluid flow transducer assembly comprising a  
12 plurality of transducer modules fastened together in stacked  
13 fashion, each of the modules having a fluid flow conduit in  
14 communication with a fluid source, a flow rate measuring  
15 transducer for measuring flow rate through the flow conduit, and  
16 an outlet for flowing fluid from the flow conduit out of the  
17 module. The outlet of each of the modules extends through the  
18 module from one side to another, and a collar member is disposed  
19 at one end in the outlet of a first of the modules and at a second  
20 end in the outlet of a second of the modules to align the first  
21 and second modules. The outlets and the collar members form a  
22 common outlet conduit for the modules.

23 The above and other features of the invention, including  
24 various novel details of construction and combinations of parts,  
25 will now be more particularly described with reference to the

1 accompanying drawings. It will be understood that the particular  
2 devices embodying the invention are shown by way of illustration  
3 only and not as limitations of the invention. The principles and  
4 features of this invention may be employed in various and numerous  
5 embodiments without departing from the scope of the invention.

#### 6 7 BRIEF DESCRIPTION OF THE DRAWINGS

8 Reference is made to the accompanying drawings in which are  
9 shown illustrative embodiments of the invention, from which its  
10 novel features and advantages will be apparent.

11 In the drawings:

12 FIG. 1 is a diagrammatic, generally sectional, partly broken-  
13 away view of one form of fluid flow transducer module illustrative  
14 of an embodiment of the invention;

15 FIG. 1A is similar to a portion of FIG. 1, but illustrative  
16 of an alternative embodiment of fluid flow transducer module;

17 FIG. 2 is an exploded view of five modules of the type shown  
18 in FIG. 1;

19 FIG. 3 is a perspective view of the modules of FIG. 2  
20 fastened together in stacked relationship to form a fluid flow  
21 transducer assembly illustrative of a further embodiment of the  
22 invention;

23 FIG. 4 is a perspective view of the assembly of FIG. 3, and  
24 illustrating an alternative embodiment in which each module is  
25 provided with two side-by-side fluid flow conduits; and

1           FIG. 5 is a perspective view of the assembly of FIG. 4 shown  
2           mounted on a fluid receiving, monitoring, treating and recycling  
3           apparatus illustrative of an exemplary use of the invention.

#### 4 5           DESCRIPTION OF THE PREFERRED EMBODIMENTS

6           Referring to FIG. 1, it will be seen that an illustrative  
7           fluid flow transducer module 10 includes a fluid flow conduit 12  
8           having an inlet 14 for receiving fluid from a fluid discharging  
9           apparatus, such as a chiller or other fluid conditioner (not  
10          shown). The conduit inlet 14 is adapted, as by threads 16, or  
11          other connecting means, to receive an external pipe or hose  
12          adapter fitting connection 18 (FIG. 2), to effect delivery of the  
13          fluid flow to the conduit inlet 14 of the flow transducer module  
14          10.

15          The module 10 further includes a transducer 20 (FIG. 1)  
16          associated with the conduit 12 in known fashion to effect  
17          measurement of the rate of flow of the fluid therethrough. In an  
18          illustrative transducer, a wheel, or propeller blade 21, is turned  
19          by the moving fluid and has fixed thereto a magnet 22 which passes  
20          by a detector 24 which communicates with an interface, which may  
21          be a computer, or other monitoring or control device 26, as by a  
22          cable 27, and which may include a display screen 28, or other user  
23          interface. Alternatively, the computer 26 can be configured to  
24          send corrective signals 30 to pumps or valves, or the like (not  
25          shown), to modify the flow rate.

1           The fluid flow conduit 12 is provided with an outlet 32 for  
2           flowing the fluid downstream of the transducer 20 to a reservoir,  
3           such as a tank 34 (FIG. 5) located beneath the module. The outlet  
4           32 extends transversely of the conduit 12 and is provided with  
5           openings 36, 38 (FIG. 1).

6           The module 10 further includes a housing 40 in which is  
7           disposed the conduit 12, a portion of the conduit inlet 14, the  
8           conduit outlet 32, and the transducer 20. The housing 40 may be  
9           of metal or a rigid plastics material and is provided with opposed  
10          first and second walls 42, 44, each having therein one of the  
11          openings 36, 38, respectively, for the conduit outlet 32. At  
12          least one of the walls 42, 44, and usually both of the walls 42,  
13          44, is adapted for stacking engagement with a second fluid flow  
14          transducer module 50 which, in turn, is adapted for stacking  
15          engagement with a further transducer module 50a (FIGS. 2-5), and  
16          so on, with a sufficient number of transducers for a particular  
17          application.

18          To aid in quickly assembling the modules 10, 50, 50a, etc.,  
19          together, collars 52 are provided for slipping into opposed  
20          openings 36, 38. The conduit outlets 32 may be provided with  
21          internal projections, such as detents 54 (FIG. 1), for positioning  
22          and holding of the collars 52. Alternatively, each of the collars  
23          52 may be fixed in, or provided as an integral part of, one of the  
24          openings 36, 38, and adapted to enter an opposed one of the  
25          openings 36, 38 (FIG. 1A).



1           The uppermost transducer module 10a of an assembly 48 (FIGS.  
2       2-5) may be capped so as to close the upper opening 36.  
3       Alternatively, if one or more flow transducer modules with inlet  
4       and/or outlet connections independent of the common conduit is  
5       required, an independent flow transducer module 56 may be  
6       assembled in conjunction with other modules to act as an end cap  
7       for the adjacent common conduit at the interface with the  
8       uppermost fluid flow transducer module 10a. Alternatively, the  
9       module 56 may be a "dummy" block having one or more unmonitored  
10      channels therein, or may be simply a cap with no channels therein.  
11      In like manner, depending upon the function of the assembly 48,  
12      there may be an unmonitored module disposed in place of one or  
13      more of the modules 10, 10a, 50, 50a. The assembly lower opening  
14      38 may be fitted onto a return pipe 58 (FIG. 5) which extends to  
15      the reservoir 34.

16           The complete assembly 48 of fluid flow transducer modules and  
17      any independent modules may be stacked and locked together by a  
18      bar 60 (FIG. 3) which may be provided with appropriate holes  
19      therein to permit passage of the transducer cables 27  
20      therethrough. The entire assembly 48 may then be placed on the  
21      reservoir, as shown by way of example, in FIG. 5. There may be  
22      mounted on the reservoir a heat exchanger 62 with appropriate  
23      inlet and outlet pipes 64, 66, 68. In FIG. 5, one of the heat  
24      exchanger outlet pipes 66 is shown connected to the aforementioned  
25      independent fluid flow transducer module 56.

1           It will be apparent that the module shown and described  
2           herein may be used in a manner reversed to that set forth above.  
3           That is, the module may be used in a manner wherein fluid is  
4           ingested by way of pipe 58, which becomes a feed pipe, and flowed  
5           through the "outlet" 14, which in this alternative embodiment  
6           actually serves as an inlet which distributes the incoming fluid  
7           to the various fluid flow conduits 12.

8           The individual fluid flow transducer modules 10, 50 may each  
9           be provided with a selected number of fluid flow conduits 12 and  
10          associated components of the transducers 20. While each  
11          transducer module may be provided with as little as one conduit,  
12          it has been found more economical and physically compact to  
13          provide two fluid flow conduits 12 per housing 40. Higher numbers  
14          of conduits may be used, but may be unduly wasteful if only one or  
15          two conduits are needed to complete a manifold.

16          It has been found that modular fluid flow transducer modules  
17          as described above can be made quickly and inexpensively and  
18          easily stored for future use. When an order is received for a  
19          manifold having a specified number of conduits, the required  
20          number of transducer modules is fitted and fixed together to form  
21          an appropriate fluid flow transducer assembly 48 in short order.  
22          In addition to being inexpensively made and time-saving in  
23          arranging with other modules, it has been found that servicing is  
24          also quick and inexpensive. By removing the bar 60, a faulty  
25          module can be removed and replaced without further ado.

1           It will be understood that the present invention is by no  
2 means limited to the particular construction herein disclosed  
3 and/or shown in the drawings, but also comprises any modifications  
4 or equivalents within the scope of the claims. For example, the  
5 term "wall" is used in its broadest sense, meaning any boundary  
6 layer enclosing a space.